253850-5-0

# Final Briefing
# RETRIEVAL, DISPLAY, AND ANALYSIS SUPPORT TOOL FOR EARTH IMAGERY (RDAST)

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The Retrieval, Display, and Analysis Support Tool (RDAST) is a system designed to facilitate access to the wide variety of available earth imagery. Using the ARC/INFO geographic information system, RDAST converts user requirements into specific sensor parameters and searches internal and external databases for the availability of suitable imagery. Sample imagery are displayed. The current implementation is based on public systems (LANDSAT, SPOT, and several airborne collections, but is not limited to this.
This document contains viewgraphs from the final briefing for this program.



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Infrared Technology
LANDSAT
SPOT

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# RDAST Final Briefing

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## 13 September 1994
## Environmental Research Institute of Michigan
## Arlington, VA

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# Agenda

| | | |
|---|---|---|
| **Project Overview** | **Rod Anderson** | **1000** |
| **Sensor Data Comparison** | **Bill Tyler** | **1015** |
| **RDAST System** | **Chris Chiesa** | |
| **System overview** | | **1100** |
| **Demonstration** | | **1130** |
| **Discussion** | **All** | **1145** |
| **Adjorn** | | **1200** |

# Program Overview

**Contract number:** DLA 900-88-D0392 DO 052

**Program Objectives:** Develop tools to index, search and compile available imagery of the earth's surface for military and dual use purposes.

**Period of Performance**: 9/28/93 -8/27/93 (with extension)

**Milestones:**

| | |
|---|---|
| Planning meeting: | 19 Jan 1994 |
| Interim briefing: | 31 Mar 1994 |
| Final briefing: | 13 Sep 1994 |

# Obstacles to Efficient Use of Available Datasets

- Sheer numbers of satellites, sensors, and observations have hampered a systematic assessment of the utility of various combinations.
- Data and sensor fusion techniques have been insufficiently mature to extract useful information from disparate data sets.
- Fusion techniques require extensive knowledge of sensor parameters and ground truth.
- National security considerations limit access to certain data sets.
- Requirements on information content and data extraction methods differ greatly with user needs.

# RDAST Approach

- **Task 1: Image Identification and Compilation**
  - Identify sources of earth imagery from airborne and space-based sensors
  - Develop indexing schemes that identify imagery available of earth scenes
  - Compile "Metadata" each included sensor mode

- **Task 2: Image Evaluation**
  - Develop measures of image goodness, based on user requirements
  - Characterize the quality of image sets using ground truth and other measures
  - Develop a system for consistent annotation of selected images

- **Task 3. Coordination and Requirements Development**
  - Identify specific user groups to use as benchmarks in requirements development
  - Assess group needs and derive requirements
  - Review and assess features of existing data archiving and retrieval systems.

- **Task 4. Sensor Data Comparison**
  - Select two space-based or airborne sensors
  - Display the extraction of information using data and sensor fusion techniques
  - illustrate multiple phenomenology representations

| RDAST | *Data Base Development and Demonstration* | ERIM |
|---|---|---|

13 September 1994

# Retrieval, Display and Analysis Support Tool

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# Presentation Overview

- Task Background & Overview
- RDAST Data Base Description
- RDAST Prototype System Demonstration

# Task Objectives:

**Design and Implement Electronic Data Base for Storage, Retrieval and Display of Primary and Metadata for Airborne and Spaceborne Remote Sensing Systems.**

# Data Base Requirements

- **Provide Local Data Management Capabilities including Storage, Query, Retrieval and Display of Remotely-Sensed Imagery**
- **Store/Query/Retrieve Sensor Metadata**
- **Link to External Archives/Catalog Systems**

# Data Base Design

- GIS/RDBMS-Based
- Sensor Data Base
  - Metadata
  - Sample Data Sets
  - Supplementary Information
- Local Data Base
  - Metadata
  - Inventory (Images)
- External Archive Search Linkage
  - XGLIS (EDC)

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*Data Base Development and Demonstration*

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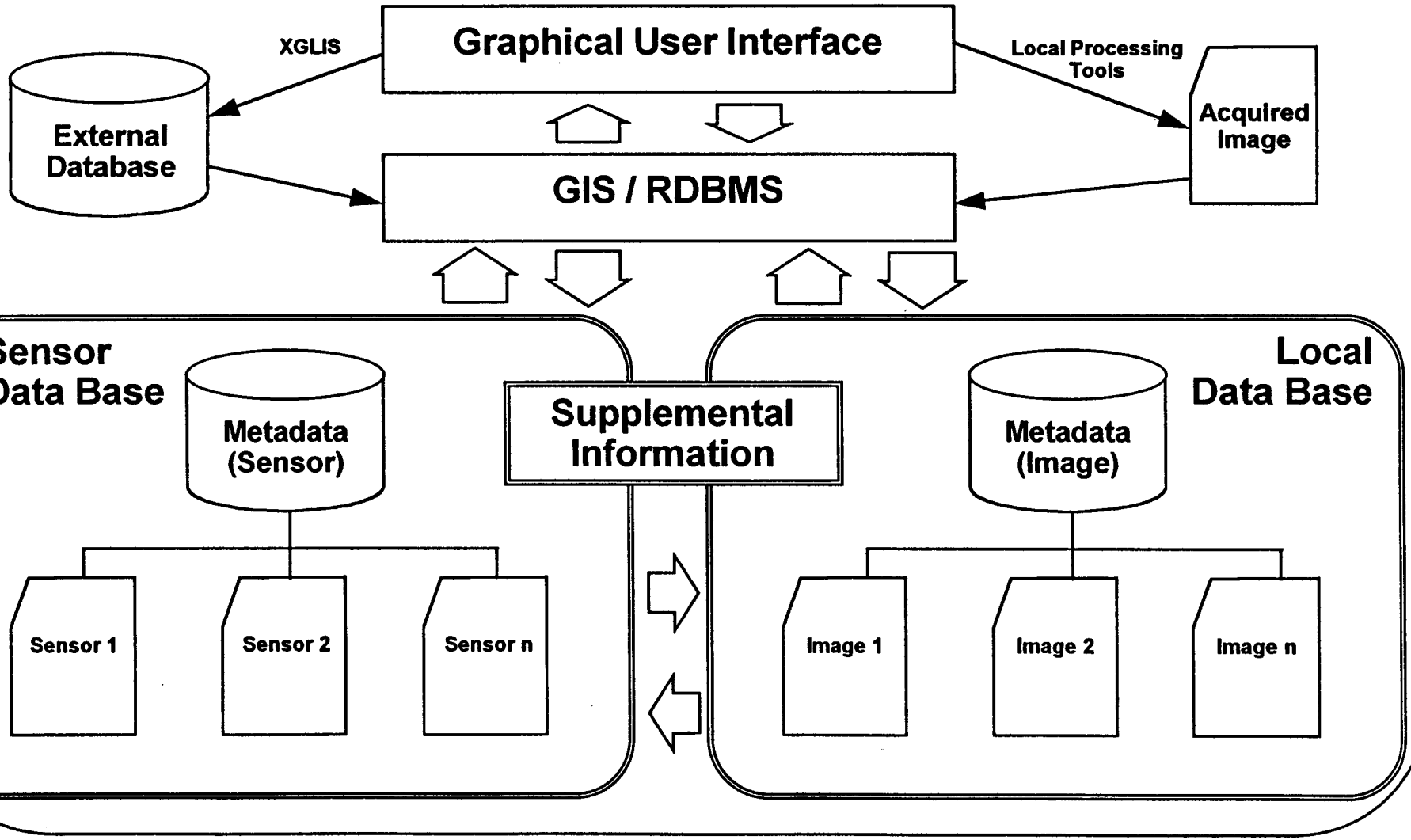
# Data Base Design



# Data Base Description

- **Sensor Database Tables**
  - SENSORBANDS: Describes RDAST sensors/platform/band info
  - BANDSTYPS: Lists valid band types
  - PLATFORMS: Lists valid image platforms
  - PLATFORMTYPS: Lists platform types (e.g. SAT/ACFT)
  - SENSORTYPS: Lists valid sensor types
  - SENSORS: Lists RDAST sensors
  - SENSORSAMPLES: Lists sample image for each sensor
- **Image Database Tables**
  - IMAGEDEFS: Describes local and sample images
  - IMAGEBANDS: Lists bands processed for each local/sample image
  - IMAGEDOCS: Lists Hypertext documents related to lcl./smpl. imgs.
  - IMAGEPROJECPARAMS: Lists projection params. for l/s imgs.
- **Support Database Tables**

# Data Base Description - IMAGEDEF Table

## 4.0 IMAGEDEF

This table is used to describe the local/sample images. Certain fields in this table are platform specific and may be left blank.

**Database Table: IMAGEDEF**

| Table Field Name | Format | Use | Description | Validation | Cross-Reference Tables |
|---|---|---|---|---|---|
| IMAGEID | Char 30 | Primary Key | The image identification name. | Uppercase. Not Null. Unique ID/ SHELF key. | IMAGEBANDS IMAGEDOCS IMAGEPROJ-PARAMS SENSORSAMPLES |
| IMAGESHELF | Char 11 | Primary Key | The unique shelf location for the image (or image name). | Uppercase. Not Null. Unique ID/ SHELF key. | IMAGEBANDS IMAGEDOCS IMAGEPROJ PARAMS SENSORSAMPLES |
| IMAGEDATE | Date | | The date of image acquisition. In the case of a mosaic image, choose a date that most fits the image. | Format DD/MM/ YY. | |
| SEASON | Char 6 | | The season that this image was acquired. (automatically calculated from imagedate when the record is added or updated from liupdate). | Must be one of: SPRING SUM-MER, AUTUMN, WIN-TER | |
| TITLE | Char 50 | | A descriptive title for the image. | | |
| SECURITY_CLASS | Char 1 | Foreign Key | The security classification of the image. Must be a valid classification as defined in the validclass table. | Uppercase. Not Null. | VALIDCLASS |

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Data Base Development and Demonstration

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# Data Base Description - IMAGEDEF Table

| Table Field Name | Format | Use | Description | Validation | Cross-Reference Tables |
|---|---|---|---|---|---|
| SENSOR | Char 10 | Foreign Key | The sensor from which the image originated. | Not Null. Must be a valid sensor from the SENSORS table. | SENSORS SENSORBANDS SENSORSAMPLES |
| PLATFORM | Char 10 | Foreign Key | The platform from which the image originated. | Not Null. Must be a valid sensor from the PLATFORMS table. | PLATFORMS SENSORBANDS |
| SENSORTYP | Char 10 | Foreign Key | The sensor type from which the image originated. | Not Null. Must be a valid type for the sensor - from the SENSORS table. | SENSORS SENSORTYPS SENSORBANDS SENSORSAMPLES |
| PLATFORMTYP | Char 10 | Foreign Key | The platform type from which the image originated. | Not Null. Must be a valid type for the platform - from the PLATFORMS table. | PLATFORMS PLATFORMTYPS SENSORBANDS |
| ARCHIVETYP | Char 20 | Foreign Key | The type of media of the image (e.g. 9-TRACK, CD-ROM). Must be a valid type as defined in the validarchivetyps table. | Must be validated against the VALIDARCHIVETYHPS table. | VALIDARCHIVETYPS |
| GEOCODE_LEVEL | Number 1 | Foreign Key | The geocode/reference level of the image. Must be a valid level as defined in the validgeocode_levels table. | Must be validated against the VALIDGEOCODE_LEVELS table. | VAKIDGEOCODE_LEVELS |
| CELLSIZE_X | Number 5 | | The cell size in the X direction (DX). | | |

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*Data Base Development and Demonstration*

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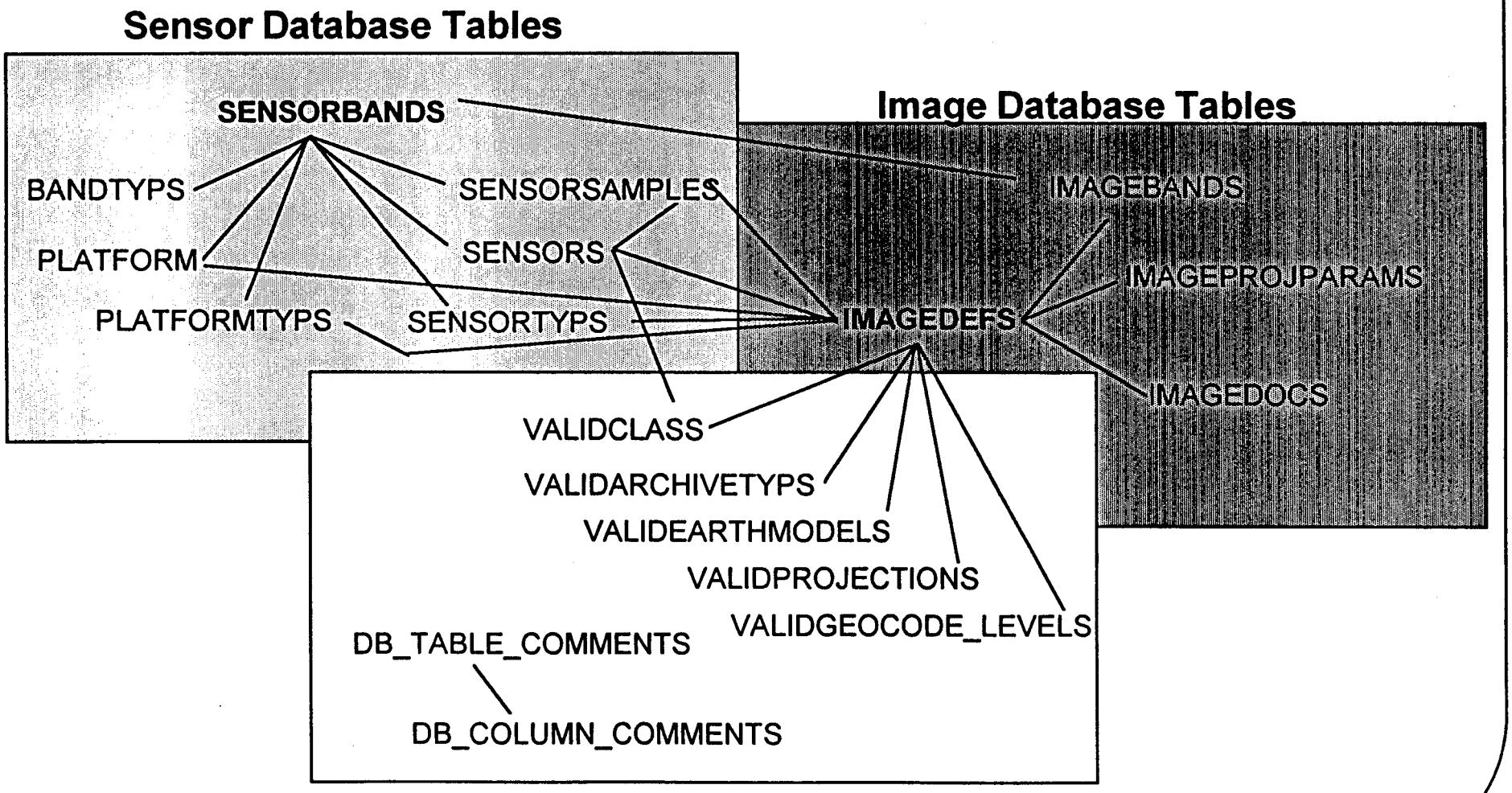
# Data Base Entity Relationship



# Data Base Implementation

- ARC/INFO Geographic Information System (GIS)
- ARC Macro Language (AML) Graphical User Interface (GUI)
- ARC/INFO Data Structures
  - INFO Tables ..... Metadata
  - Raster ..... Images
  - Topological Vector ... Boundary/Reference
- Supplemental (Guide) Sensor Information
  - Frame View Hypertext

# Operational Scenario (Sample)

- Situation Requiring Remotely Sensed Data Arises
- Query RDAST to Determine Necessary and Suitable Image Sources
- Local Data Base Searched for Availability of Imagery
- External Archive Searched for Availability of Imagery
- Data Acquired, Processed and Archived (Local DB)

# RDAST Demonstration

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# RETRIEVAL, DISPLAY, AND ANALYSIS TOOL FOR EARTH IMAGERY

## Task 4: Sensor Data Comparison

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## *Task 4 - Sensor Data Comparison Image Examples*



**TASK OBJECTIVE:** To Demonstrate the Utility of Using Commercial Space-Based and Airborne Sensors to Exploit Image data Using Information Extraction and Sensor Fusion Techniques

# Commercially Available Satellite Data

- SPOT (XS and Pan) ✓✓
- Landsat (MSS and TM) ✓✓
- AVHRR (LAC and GAC)
- JERS-1 (Optical and Microwave)
- ERS-1
- CZCS
- KFA (image or digital)

# Other Sources of Image Data

- Airborne Multispectral Scanners (M7) ✓
- Airborne Imaging RADAR Sensors (IFSARE)
- Aerial Photography

# Obtainable Ancillary Data

- Large Scale Topographic Maps
- Digital Elevation Models (for some parts of the World)
- Digital Chart of the World (DCW)
- Scanned Navigational Charts

## Task 4 - Sensor Data Comparison Image Examples

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By Combining Commercial Remote Sensing Images With Available Ancillary Data, Information Products May Be Generated

# Examples of Satellite-Derived Information Products

- Cartographically Accurate Image Maps
- Derived Images such as Categorized Images, Bathymetric Images, Enhanced Images
- Fused Image Products such as Perspective Views, Pan-Sharpened Multispectral Data, Change Images

# Information Products Generated During Task 4 Activities

- Portions of the RDAST Data Base Were Populated With Examples of Commercially Available Data
- Examples of Landsat MSS, TM, SPOT and SPOT-Sharpened Image Data Were Generated For a Variety of Geographic Areas
- A Perspective View Flythrough Loop was Produced for the RDAST Data Base
- Examples of Other Image-Derived Products were Generated: Data Fusion Examples, Change Detection, Terrain Categorization, and Spot-Sharpened TM

# Digital Files Generated for RDAST Data Base

- Ann Arbor Data (M7, TM, MSS, AVHRR)
- Chambery Data (TM, MSS, DTED, Fly-Through)
- Baghdad Data (2 TM)
- St. Charles Flood (2 TM, Spectral Features)
- Washington, D.C. (SPOT, TM, Sharpened)

# Important Dates in Commercial Remote Sensing

- July 1972 - October 1992, **Landsat MSS** Data Available
- July 1982 - Present, **Landsat TM** Data Available
- February 1986 - Present, **Spot** Data Available
- October 1979 - Present, **AVHRR** Data Available

# Pixels per Millimeter at Various Scales and Spatial Resolution

| Sensor | 1:250,000 | 1:100,000 | 1:50,000 | 1:25,000 |
|---|---|---|---|---|
| AVHRR | 0.25 | 0.1 | 0.05 | 0.025 |
| MSS | 5.0 | 2.0 | 1.0 | 0.5 |
| TM | 10.0 | 4.0 | 2.0 | 1.0 |
| SPOT-XS (20m) | 12.5 | 5.0 | 2.5 | 1.25 |
| SPOT-Pan (10m) | 25.0 | 10.0 | 5.0 | 2.5 |

# Pixels per Square Kilometer for Various Satellite Sensors

| Sensor | Resolution | Pixels/sq.km | Bands | Total Pixels/sq km |
|---|---|---|---|---|
| AVHRR | 1,100 m (nadir) | 0.9 | 5 | 4.5 |
| MSS | 80 meters | 226 | 4 | 904 |
| TM | 30 meters | 1,231 | 7 | 8,617 |
| SPOT-XS (20m) | 20 meters | 2,500 | 3 | 7,500 |
| SPOT-Pan (10m) | 10 meters | 10,000 | 1 | 10,000 |

# The SPOT Satellite System (SPOT 1 - 3)

- SPOT Acronym: *Systeme Pour l'Observation de la Terre*
- Development of the SPOT System
  - launch facility in South America
  - CNES: *Centre National d'Etudes Spatiales* (like NASA in the U.S.)
  - Toulouse: SPOT Image Headquarters
- SICORP
  - U.S. Distributor of SPOT Data

# The HRV (*Haut Resolution, Visible*) Sensor

- Pushbroom Design: No Moving Parts
- Spectral Resolution
  - panchromatic mode 0.51-0.73 μm
  - XS mode, 3 bands 0.50-0.89 μm
- Spatial Resolution
  - panchromatic mode 10 m
  - XS mode 20 m

# SPOT Satellite Orbit

- Sun Synchronous
- Near Polar
- Overpass Time: 10:30 AM at Equator
- Off-Nadir Viewing
  - Advantages: Rapid Revisit (2.5 days on average), Stereo Coverage Possible
  - Disadvantages: More Complex Geometric Correction Algorithms

# SPOT Scene Geometry

- Nominal SPOT Frame Size 60 x 60 km
- Off-Nadir: up to 80 x 60 km
- Number of Pixels
  - panchromatic mode: 6,000 x 6,000
  - XS mode: 3,000 x 3,000 x 3 bands

# Memory Requirements

- SPOT Pan scene: 6,000 x 6,000 = 36 Mbytes per scene
- SPOT XS scene: 3,000 x 3,000 x 3 = 27 Mbytes per scene
- One degree x One degree Area: 6 - 8 SPOT scenes required

# Satellite Locator Map

- GRS sheets: *(Grille de Reference SPOT)* map series @ 1:5,000,000 scale showing scene center locations
- K/J Coordinates
  - "K" coordinates along track of satellite
  - "J" coordinates analogous to lines of latitude (equator J>350)

# The Landsat Satellite System

- Landsat 1 Launched in July 1972
  - carried Return Beam Vidicon (RBV) and Multispectral Scanner (MSS)
  - Landsats 2 & 3 carried same two sensors
- Landsat 4 Launched in July 1982
  - carried Thematic Mapper (TM) and Multispectral Scanner (MSS)
  - Landsat 5, launched in March 1984, carried same two sensors

# The Multispectral Scanner

- Spatial Resolution Approximately 80 meters
- Spectral Resolution: 4 Broad Spectral Bands from 0.5 - 1.1μm
- Radiometric Resolution: 6-bits/pixel/band

# The Thematic Mapper

- Spatial Resolution 30 meters
- Spectral Resolution: 6 Spectral Bands from 0.45 - 2.35μm, plus one thermal band
- Radiometric Resolution: 8-bits/pixel/band

# Landsat Satellite Orbit

- Sun Synchronous
- Near Polar
- Overpass Time: 9:30 AM at Equator
- Revisit Every 16 Days (18 days for Landsat 1-3)

# Landsat Scene Geometry

- Landsat Scene 185 x 185 km
- Amount of Sidelap Varies with Latitude
- Number of Pixels
  - nominal size 5965 rows x 6967 columns (41.56 Mbytes/band)

# Landsat Scene Storage Requirements

- Landsat TM scene: 5,965 x 6,967 = 41.56 Mbytes per band
- Full Frame: 5,965 x 6,967 x 7 = 291 Mbytes
- MSS data: 2300 x 3264 x 4 = 30 Mbytes
- One degree x One degree Area: 1 - 4 Landsat scenes required

# Ann Arbor, Michigan

- M7 Data for Willow Run Airport (geocoded)
- Landsat MSS Data From August 1990 (geocoded)
- Landsat TM Data From May 1992 (geocoded)

# Chambery, France

- Landsat MSS Data From May 1976 (geocoded)
- Landsat TM Data From July 1984 (geocoded)
- Digital Elevation Model Generated from 3 Arc-Second DTED Data
- Animated Fly-Through Sequence Produced

# Baghdad, Iraq

- Landsat TM Data From January 1990
  (geocoded using satellite ephemeris)
- Landsat TM Data From January 1991
  (geocoded using satellite ephemeris)

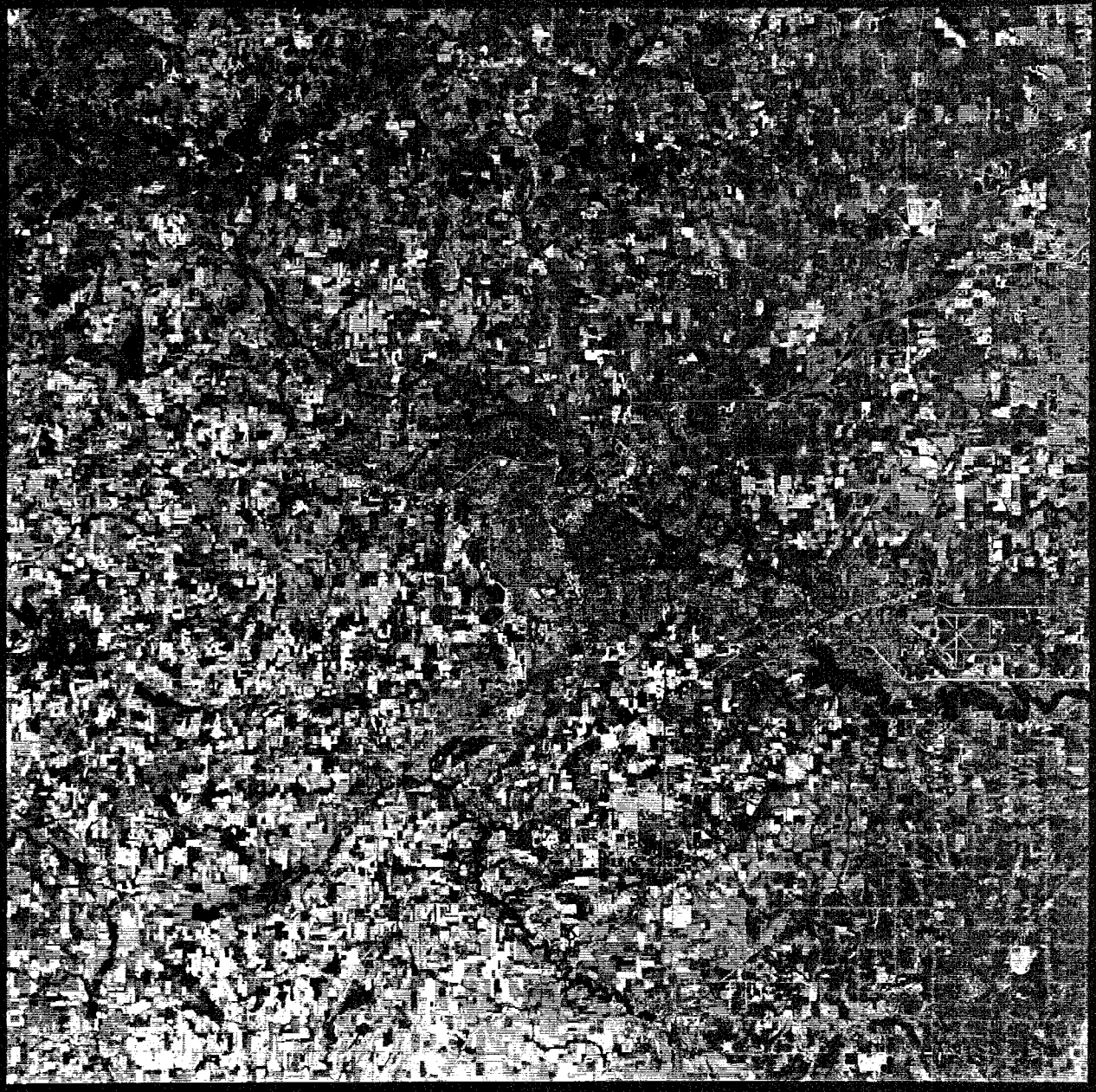
# St. Charles, Missouri

- Landsat TM Data From 15 July 1986, Geocoded, Pre-Flood Data
- Landsat TM Data From 18 July 1993, Geocoded, Flood Near Peak
- Various Derived Images (Flood Extent, Flooded Agricultural Land, etc.)

# Summary

- Commercial Satellite are Data Available For Most of the World at a Variety of Resolutions
- SPOT Data (10m spatial resolution) Useful at Scales as Large as 1:20,000
- Landsat TM Data (30m) Useful at Scales as Large as 1:50,000
- Commercial Data May Be Used To Derive a Variety of Information Products

# Ann Arbor, Michigan



Landsat Thematic Mapper (TM) Data, Partial Scene
False Color Composite
Bands 4 3 2 / R G B
Path 20 Row 30
Scene Date: 16 May 1992

0 5 10 Kilometers

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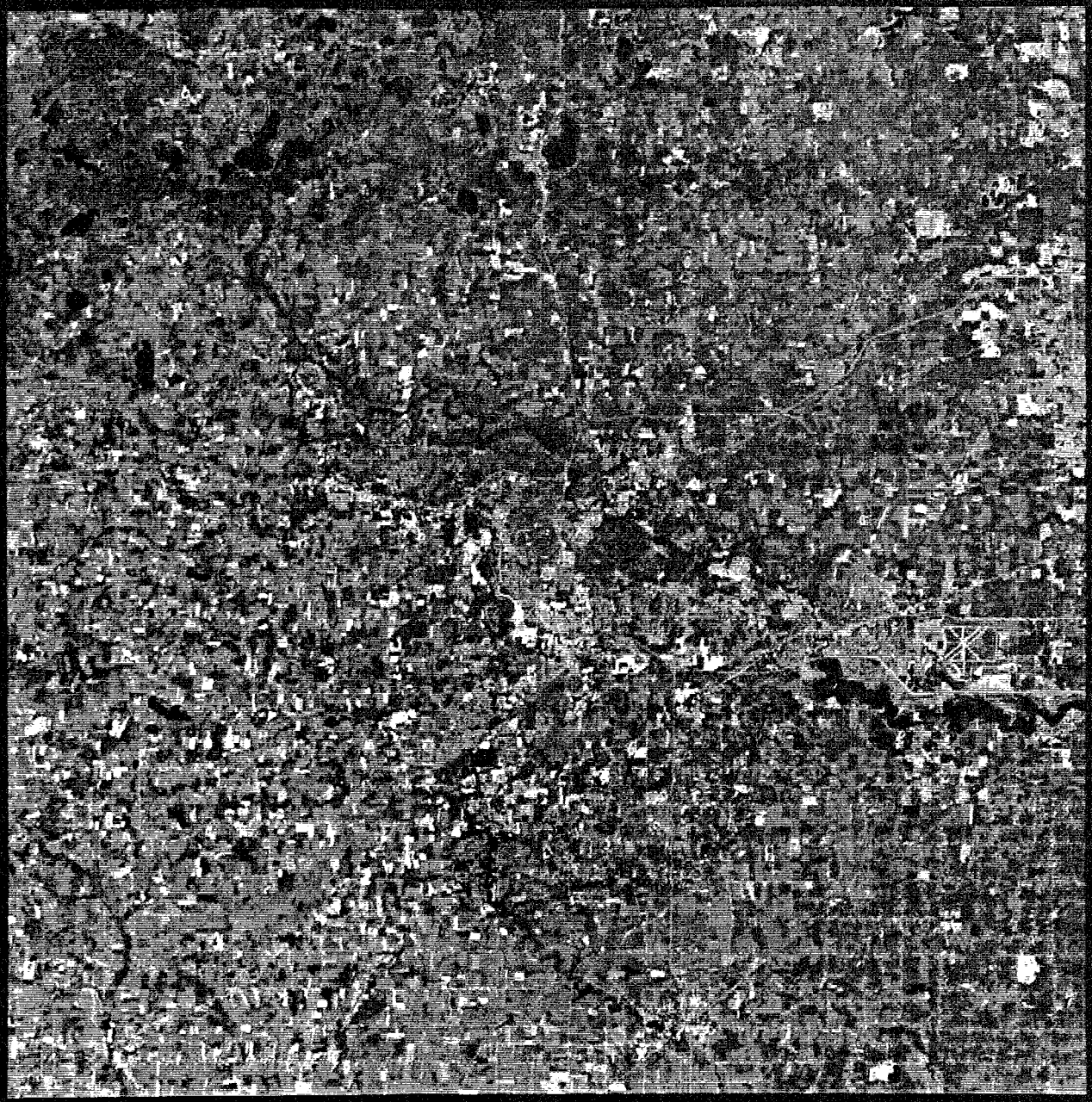
# Ann Arbor, Michigan

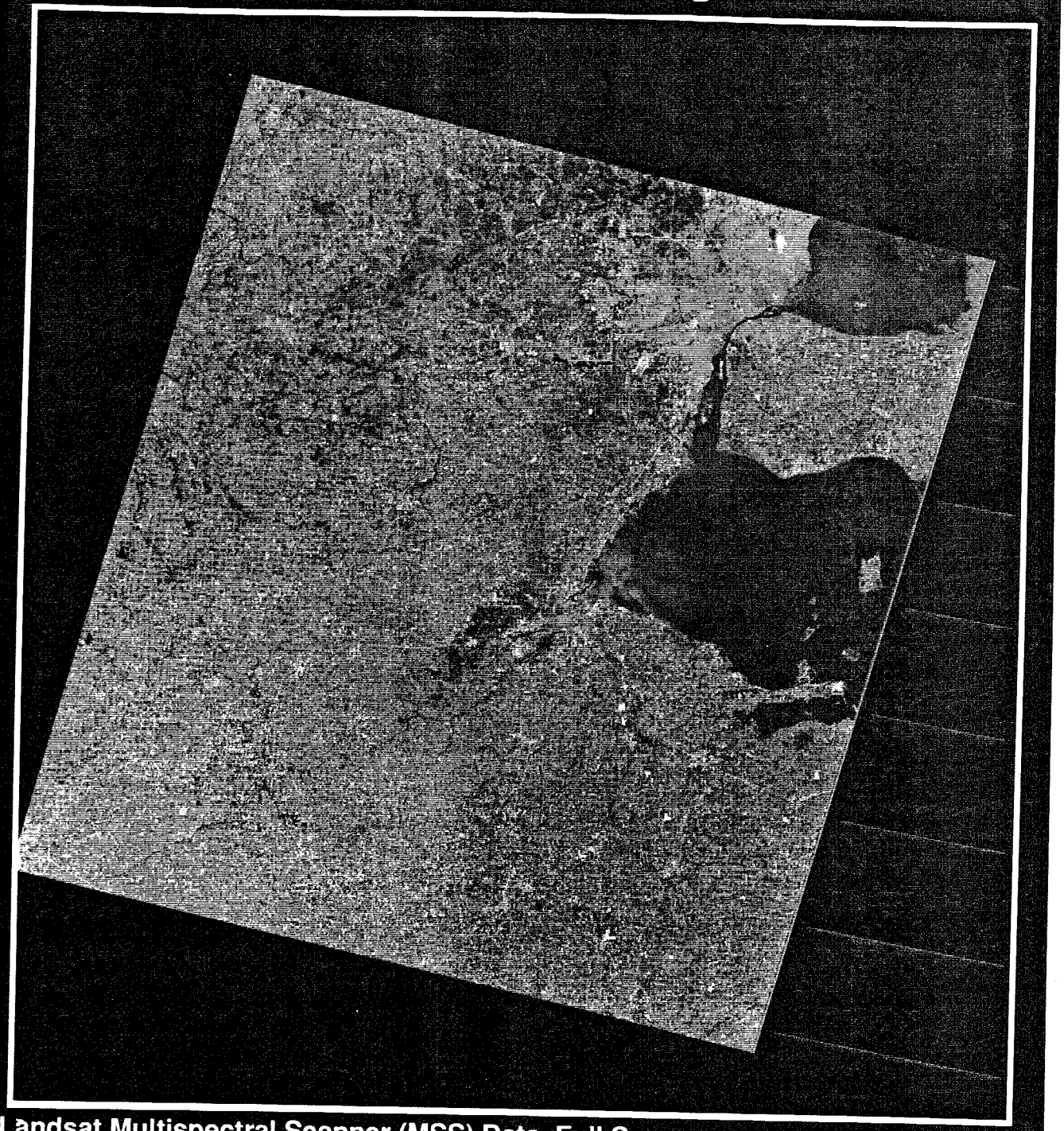


Landsat Multispectral Scanner (MSS) Data, Partial Scene
False Color Composite
Bands 4 2 1 / R G B
Path 20 Row 31
Scene Date: 31 August 1990

0 5 10 Kilometers

ERIM

# Ann Arbor, Michigan



Landsat Multispectral Scanner (MSS) Data, Full Scene
False Color Composite
Bands 4 2 1 / R G B
Path 20 Row 31
Scene Date: 31 August 1990

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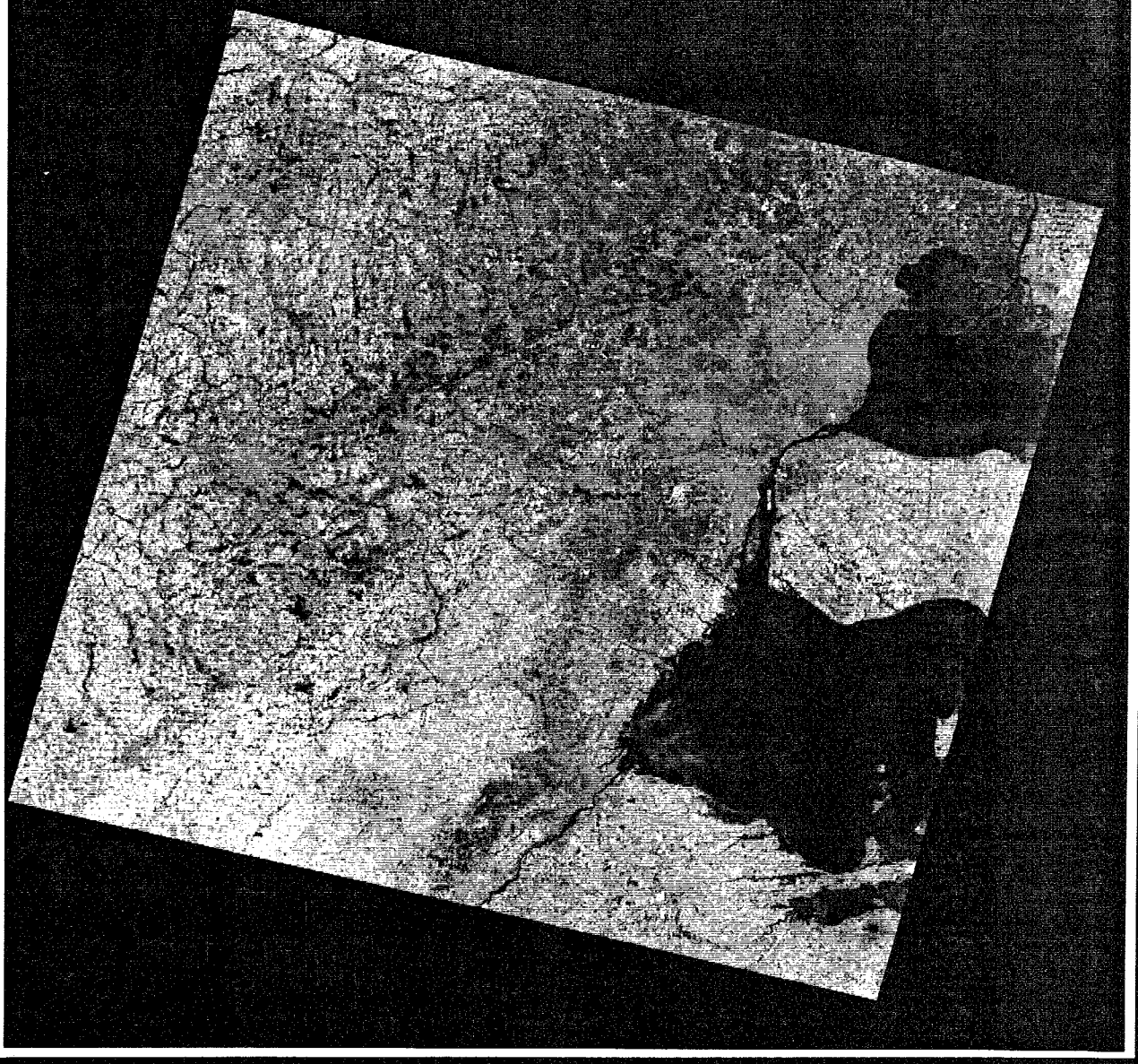
# Ann Arbor, Michigan



**Landsat Thematic Mapper (TM) Data, Full Scene**
**False Color Composite**
**Bands 4 3 2 / R G B**
**Path 20 Row 30**
**Scene Date: 16 May 1992**

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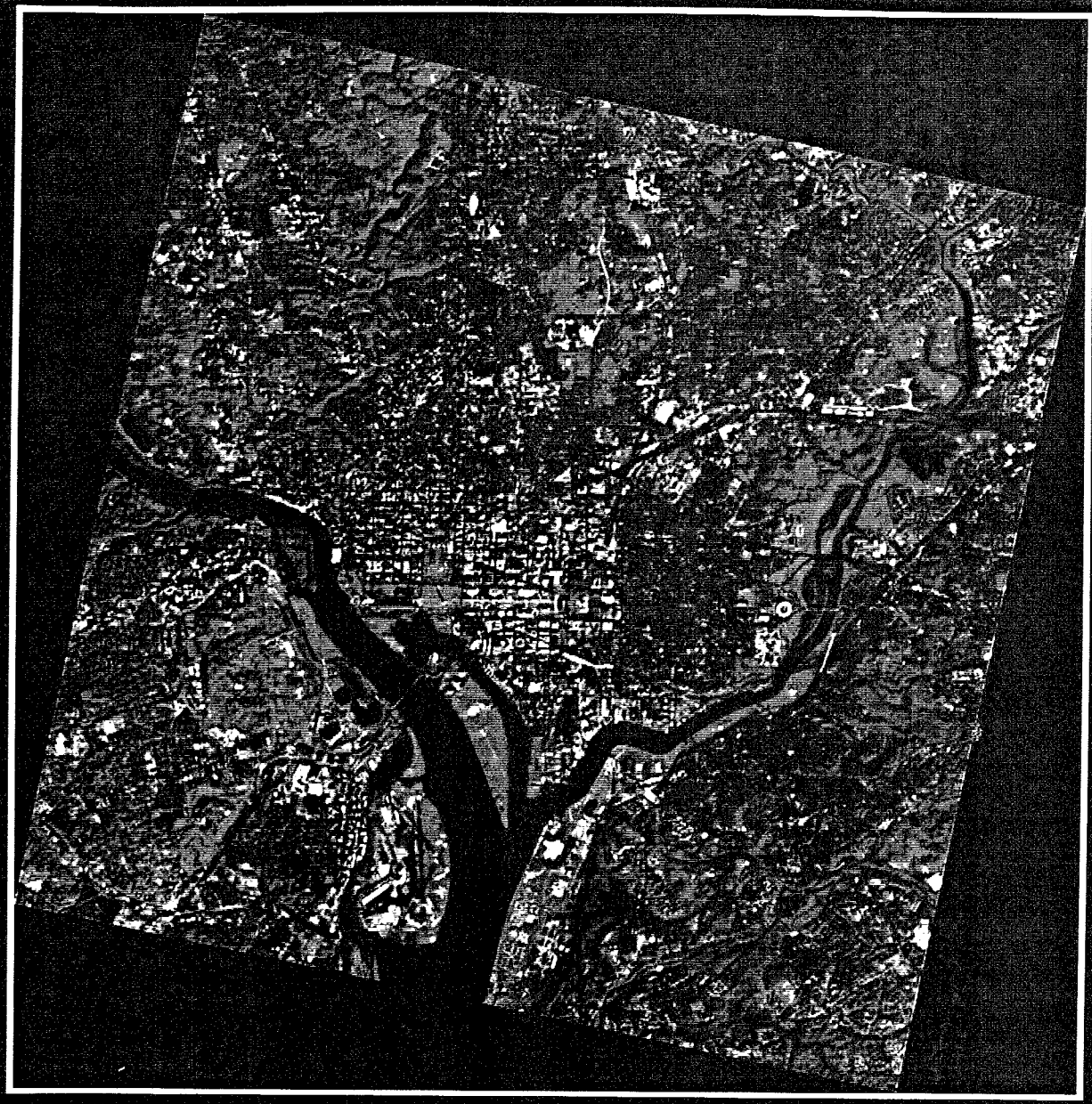
# Washington, D.C.



Landsat Thematic Mapper (TM) Data
False Color Composite
Bands 4 3 2 / R G B
Scene Date: 23 October 1993
Resampled to 20 m cells, UTM Projection

0 2 4 Kilometers

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# Washington, D.C.



0 2 4 Kilometers

**SPOT Panchromatic Data**
**K 623 J 272**
**Scene Date: 28 September 1993**
**Resampled to 10 m cells, UTM Projection**

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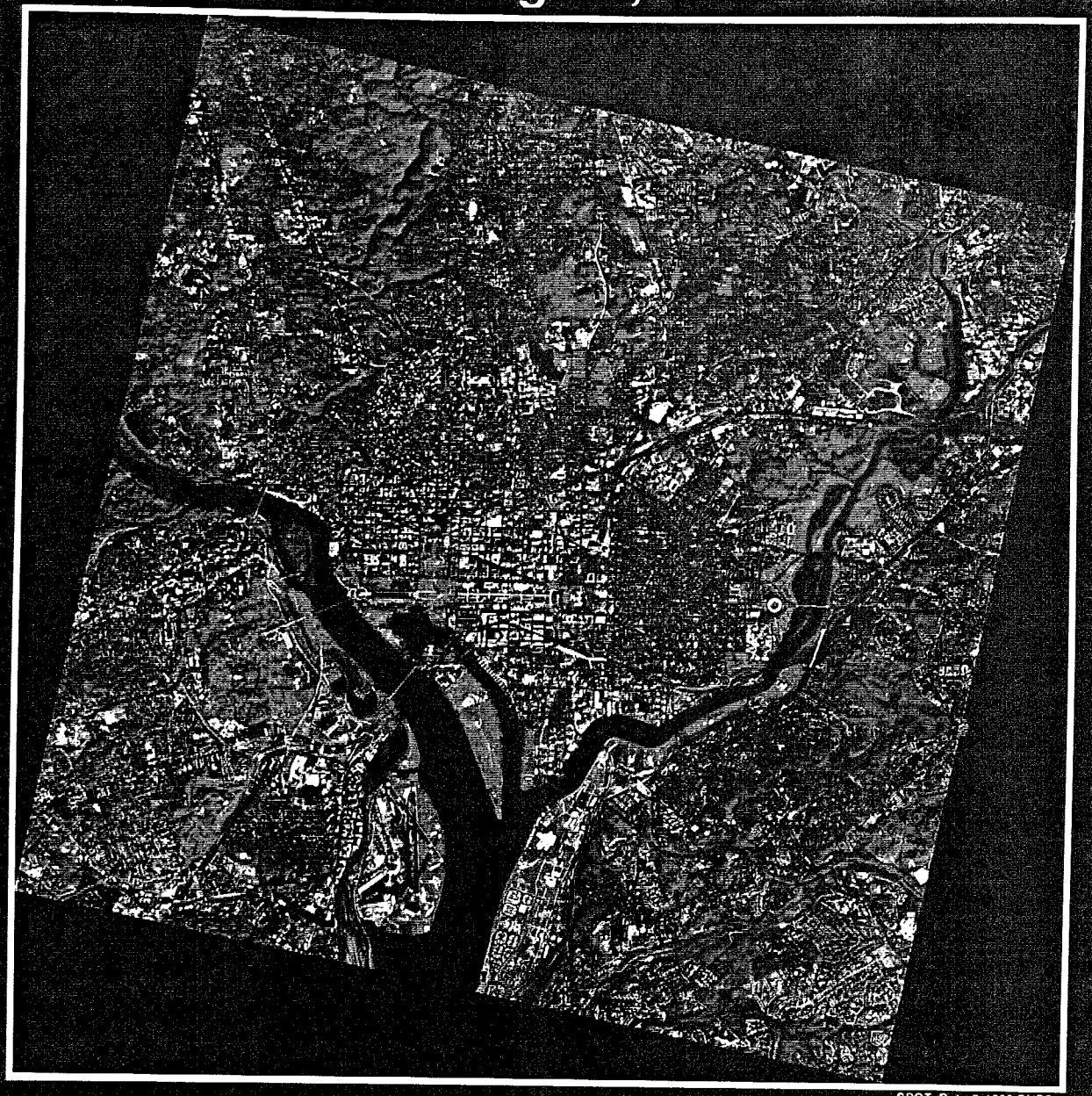
# Washington, D.C.





SPOT-Sharpened TM Data
SPOT Pan Data and TM Bands 432/RGB
SPOT Scene Date: 28 September 1993
TM Scene Date: 23 October 1993
Resampled to 10 m cells, UTM Projection
Sharpening Algorithm: SPARKLE

0 2 4 Kilometers

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# St. Charles, Missouri
# Flood Extent, 18 July 1993

Flood Mask (Red) Overlayed on Natural Color Image

0 2 4 Kilometers

Scene Date: 18 July 1993

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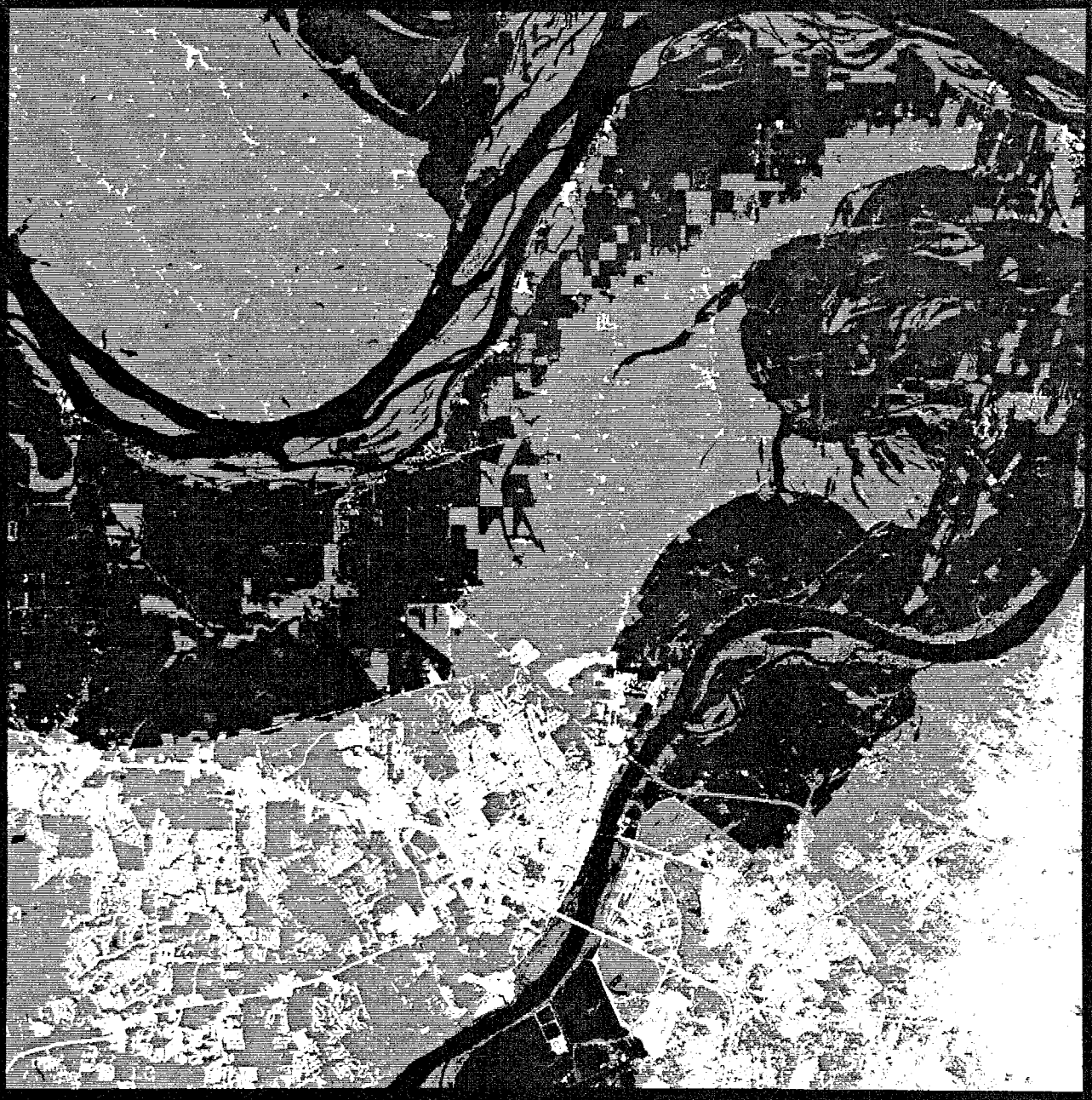
# St. Charles, Missouri
# Flooded Cultural Features



Water Feature 1986: Blue
Water Feature 1993: Green
Built-Up Land: Red

0 2 4 Kilometers

**Interpretation Key:**

Dark Blue = Flooded Areas
Magenta = Flooded Roads/ Parking Lots
White = Flooded Buildings
(if Surrounded by Blue)

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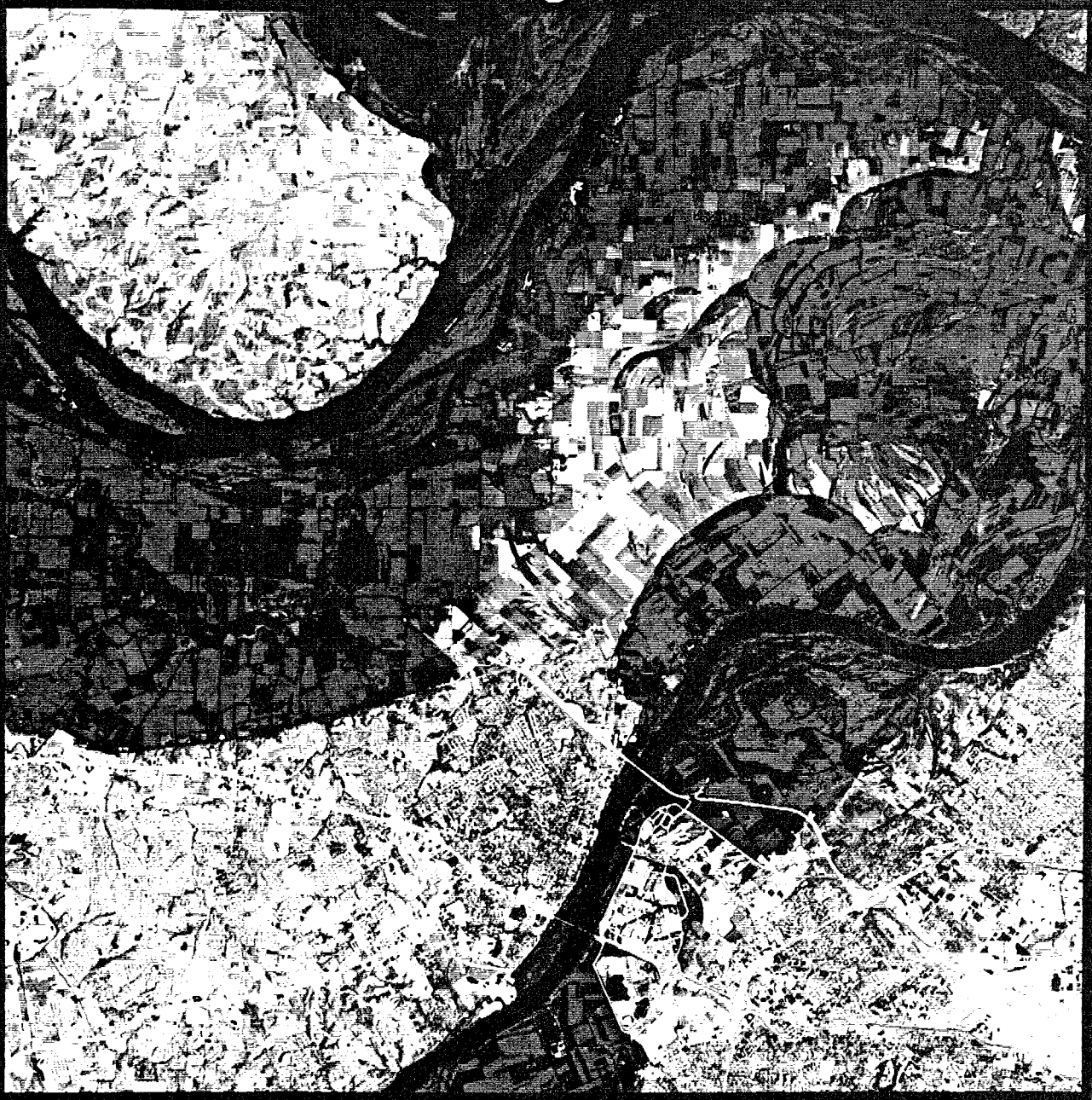
# St. Charles, Missouri
# Flooded Agriculture



**Flooded Agricultural Land (Green) Overlayed on Tasseled Cap Brightness Spectral Feature**

0 2 4 Kilometers

**Scene Date: 18 July 1993**

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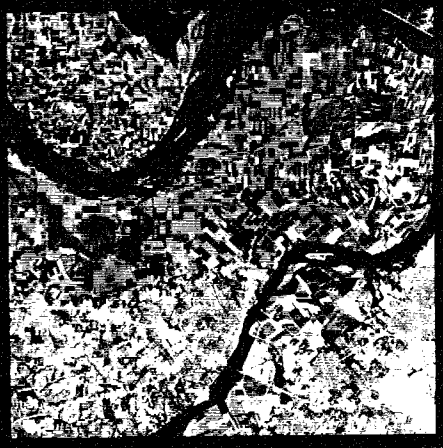
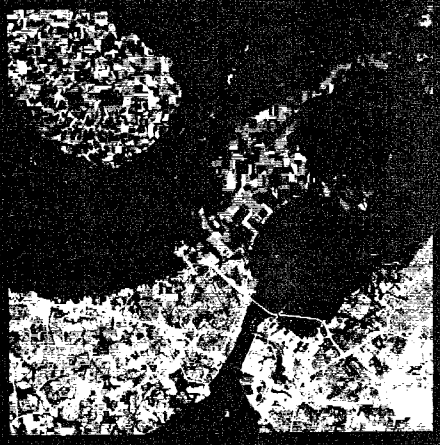
# St. Charles, Missouri

15 July 1986
Landsat TM Bands 321/RGB
(Natural Color Composite)

18 July 1993
Landsat TM Bands 321/RGB
(Natural Color Composite)



Water Feature



Water Feature

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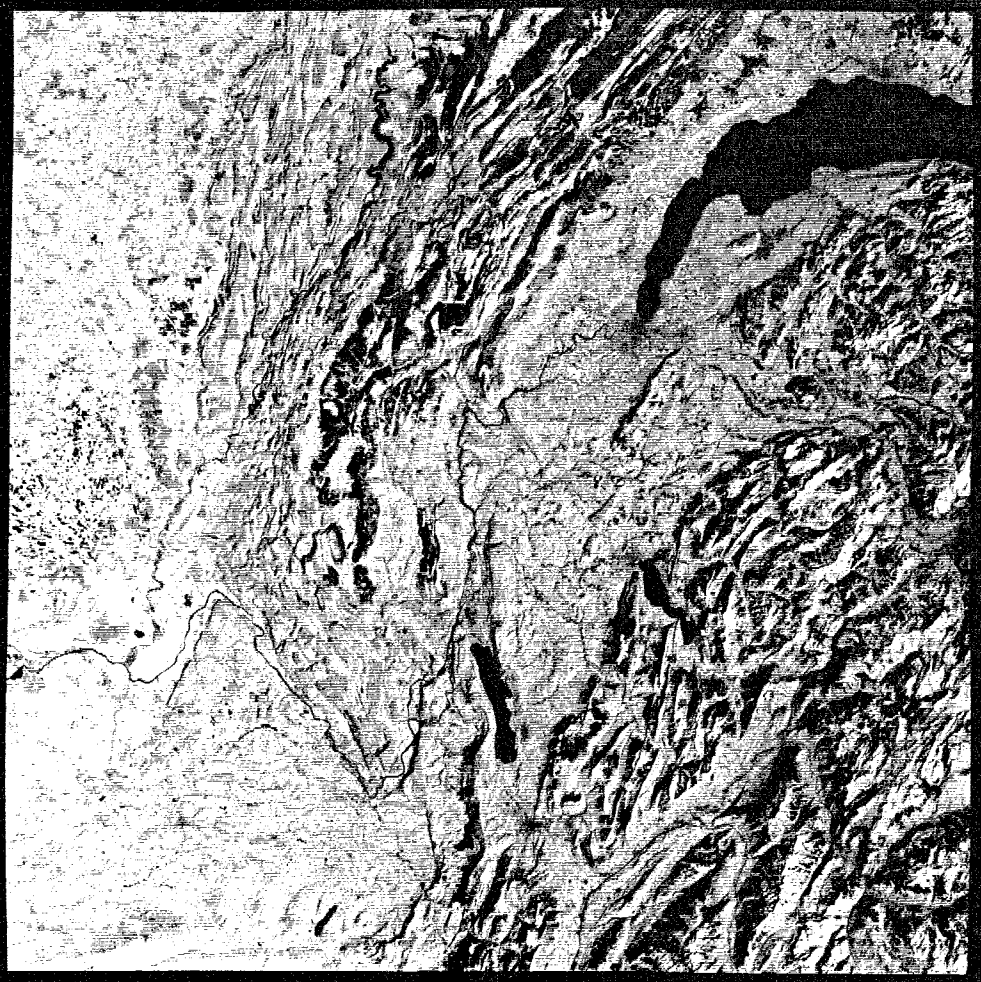
# Chambery, France




Landsat Thematic Mapper (TM) Data
False Color Composite
Bands 7 4 2 / R G B
Path 196 Row 28
Scene Date: 30 July 1984
Resampled to 25 m cells, Lambert Projection

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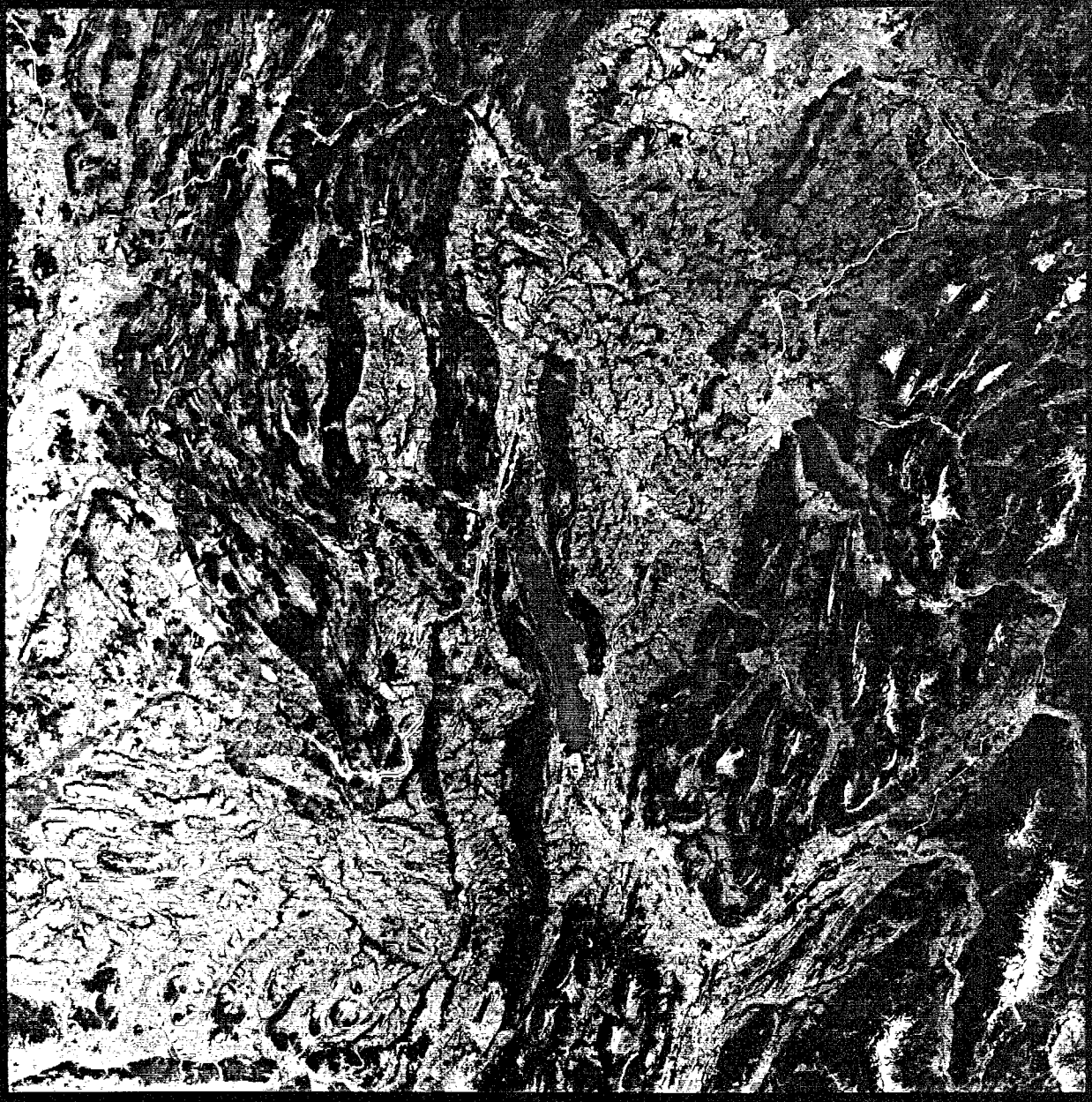
# Chambery, France



Landsat Thematic Mapper (TM) Data, Partial Scene
Natural Color Composite
Bands 3 2 1 / R G B
Path 196 Row 28
Scene Date: 30 July 1984
Resampled to 25 m cells, Lambert Projection

0 10 20 Kilometers

ERIM

# Perspective View Fly - Through

Frame 47

Frame 60

Frame 117

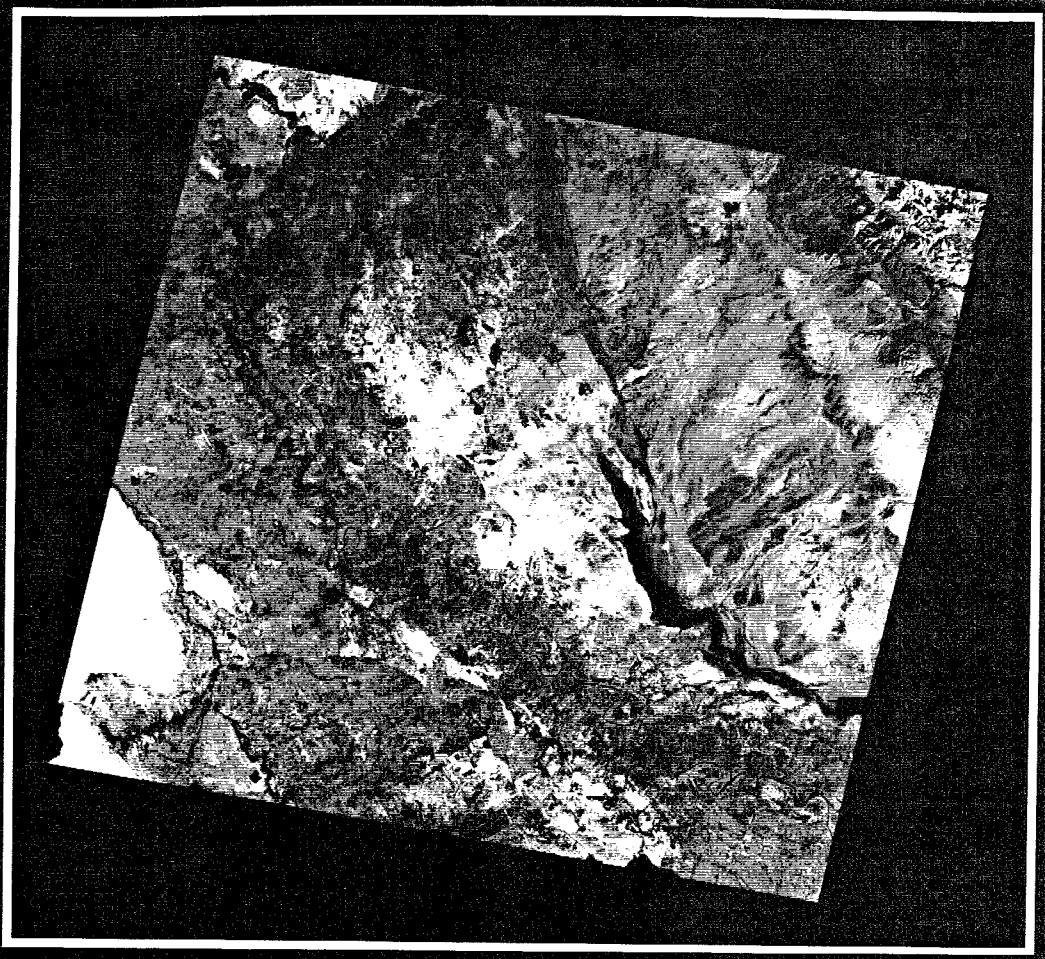
Frame 130

Landsat TM
Natural Color
Scene Date: 30 July 1984
Path/ Row: 196-28

3 Arc - Second DTED

ERIM

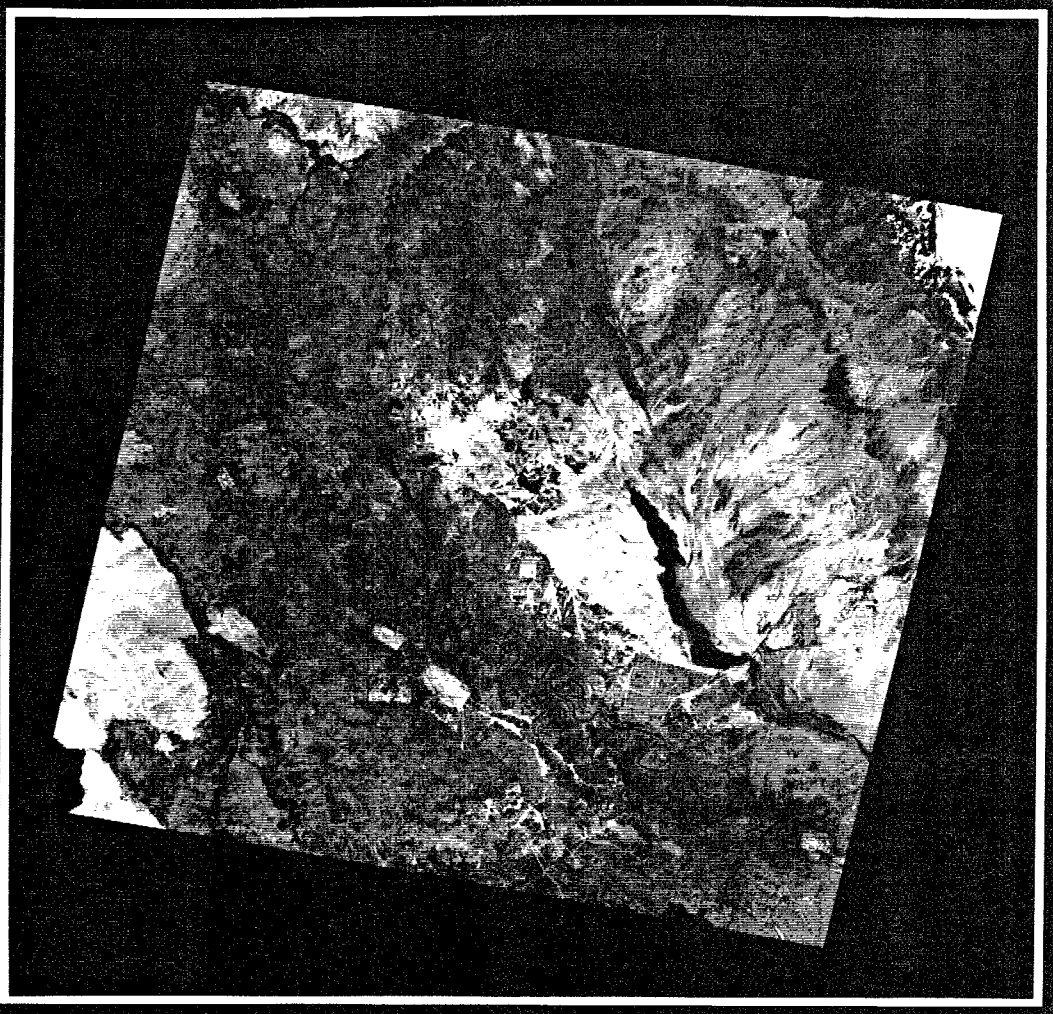
# Baghdad, Iraq



Landsat Thematic Mapper (TM) Data, Full Scene
False Color Compoosite
Bands 7 4 2 / R G B
Path 168 Row 37
Scene Date: 8 January 1990
Resampled to 25 m cells, UTM Projection

ERIM

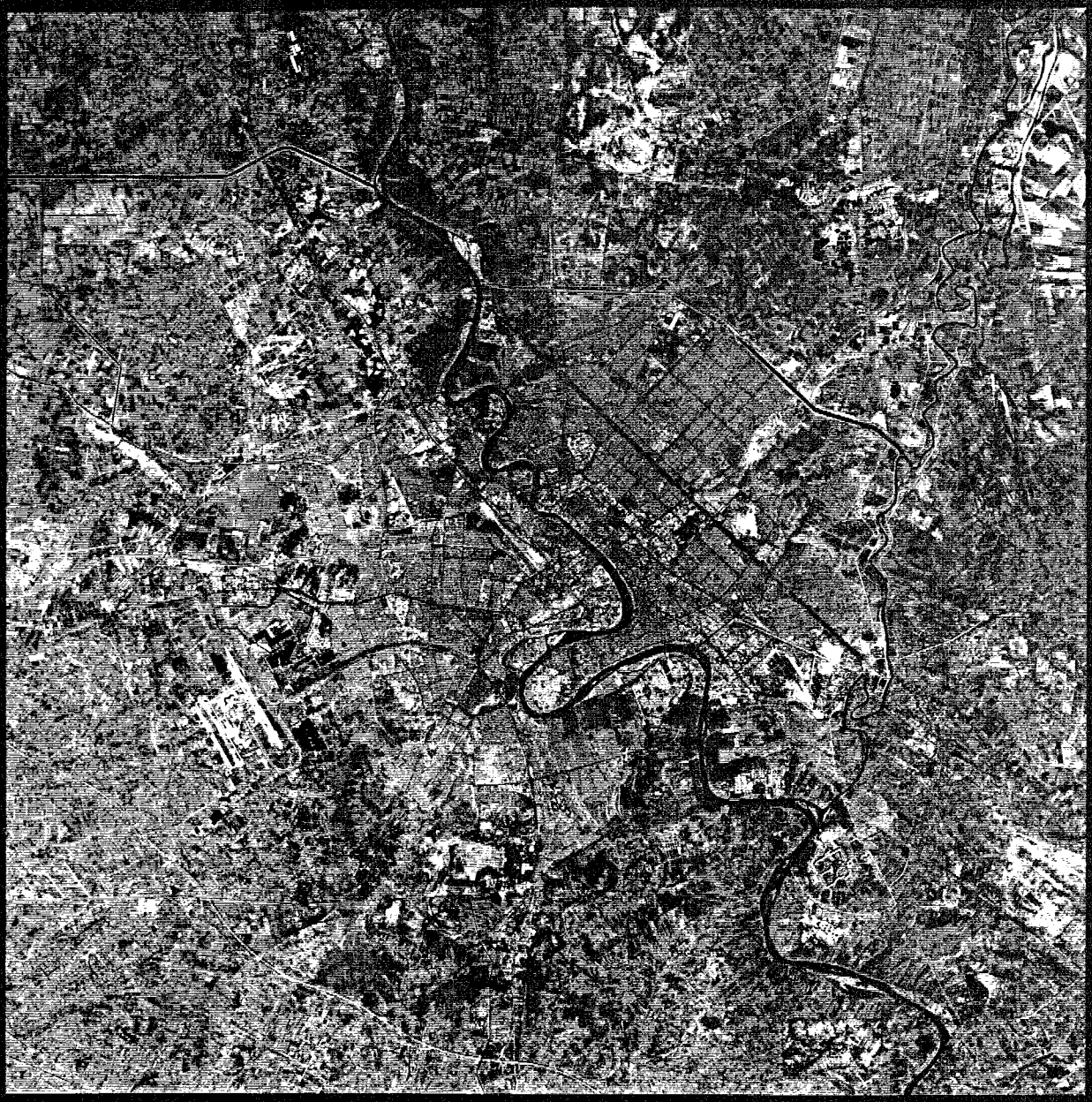
# Baghdad, Iraq



Landsat Thematic Mapper (TM) Data, Full Scene
False Color Composite
Bands 7 4 2 / R G B
Path 168 Row 37
Scene Date: 27 January 1991
Resampled to 25 m cells, UTM Projection

ERIM

# Baghdad and Environs



Landsat Thematic Mapper (TM) Data, Partial Scene
False Color Composite
Bands 7 4 2 / R G B
Path 168 Row 37
Scene Date: 8 January 1990
Resampled to 25 m cells, UTM Projection

0 5 10 Kilometers

ERIM

# Baghdad and Environs

Landsat Thematic Mapper (TM) Data, Partial Scene
False Color Composite
Bands 7 4 2 / R G B
Path 168 Row 37
Scene Date: 27 January 1991
Resampled to 25 m cells, UTM Projection

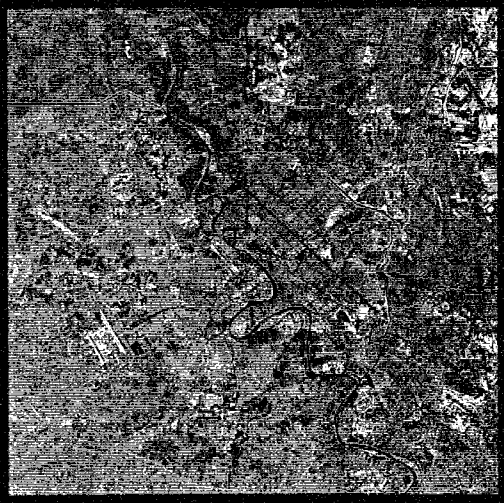
0 5 10 Kilometers

ERIM

# Spatial Filters
# Baghdad, Iraq

Raw Data TM 742/RGB

Laplacian



11 x 11 Boxcar

51 x 51 Boxcar

**Landsat TM Data**
**Scene Date: 8 Jan 1990**
**Path 168 Row 37**

ERIM